(12) UK Patent Application (19) GB (11) 2 182 603 (13) A

(43) Application published 20 May 1987

(21) Application No 8626100

(22) Date of filing 31 Oct 1986

(30) Priority data

(31) 8527300 (32) 6 Nov 1985 (33) GB

(71) Applicant
The Victaulic Company Plc,
(Incorporated in United Kingdom),
46-48 Wilbury Way, Hitchin, Hertfordshire

(72) Inventors
David John Hill,
Keith Andrew Wilson

(74) Agent and/or Address for Service
Fry Heath & Co., Seloduct House, Station Road, Redhill, Surrey

(51) INT CL[4]
B29C 47/90

(52) Domestic classification (Edition I)
B5A 1G10 1G15 1G3B 1G3X 1R214F 1R314C1C 1R314C1S 1R314C1X 1R322 1R429X 2A3 2B1 2C 2L 2P2 T17S

(56) Documents cited
GB 1573574
GB 1417312
GB 1370854
GB 0967411
GB 0959440
GB 0783449
GB 0780900

(58) Field of search
B5A
Selected US specifications from IPC sub-class B29C

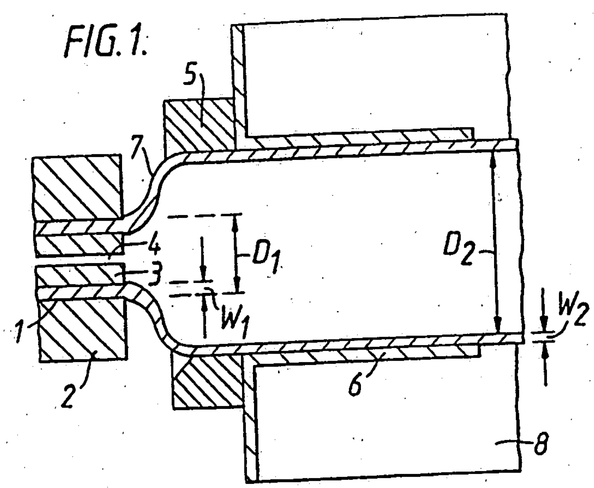
(54) Transversely expanding and calibrating an extruded hollow product

(57) Plasticated thermoplastics or rubber material is extruded through an annular die (2) to form an elongate hollow product (7) which is then subjected to a pressure difference across its side walls whilst still soft and thereby transversely expanded, prior to being calibrated and cooled in its expanded configuration during passage through a perforated sleeve (6), within a vacuum tank (8).

The pressure difference may be effected by internal pressure admitted through a die passage (4) and/or vacuum applied externally within an enclosure between the die and the perforated sleeve.

The transverse expansion produces transverse orientation in the product wall, and increased strength arising from incorporated reinforcement e.g. glass fibres, or from the material being a self reinforcing polymer, such as a liquid crystal polymer.

FIG. 1.



GB 2 182 603 A

26100 - 31OCT.86
D.F.A.

2182603

FIG.1.

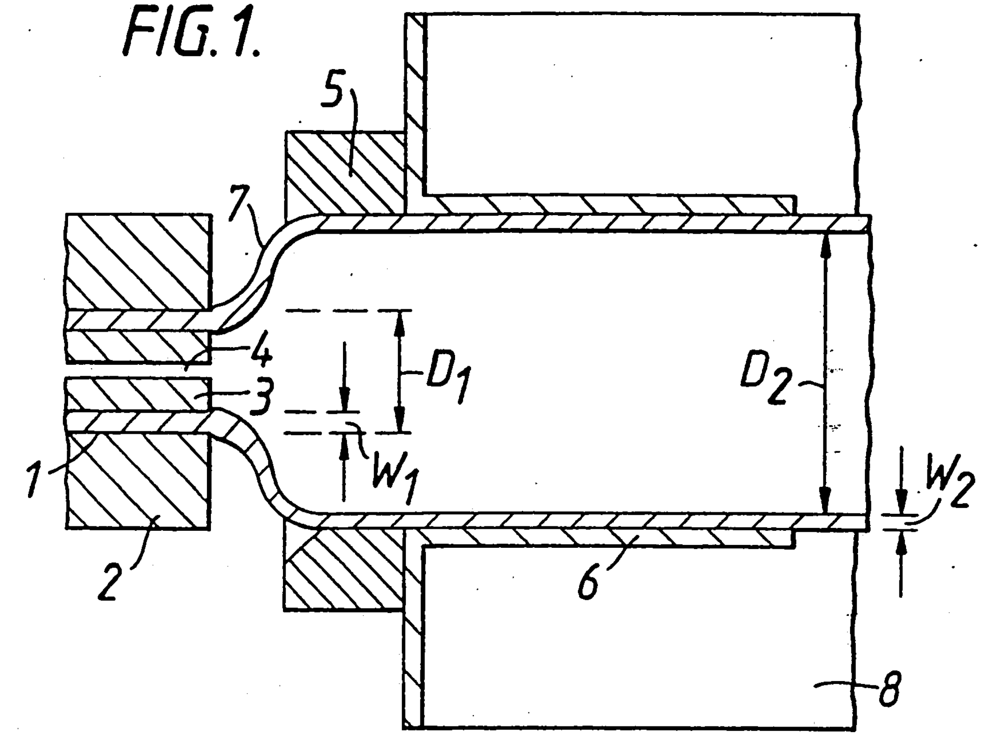
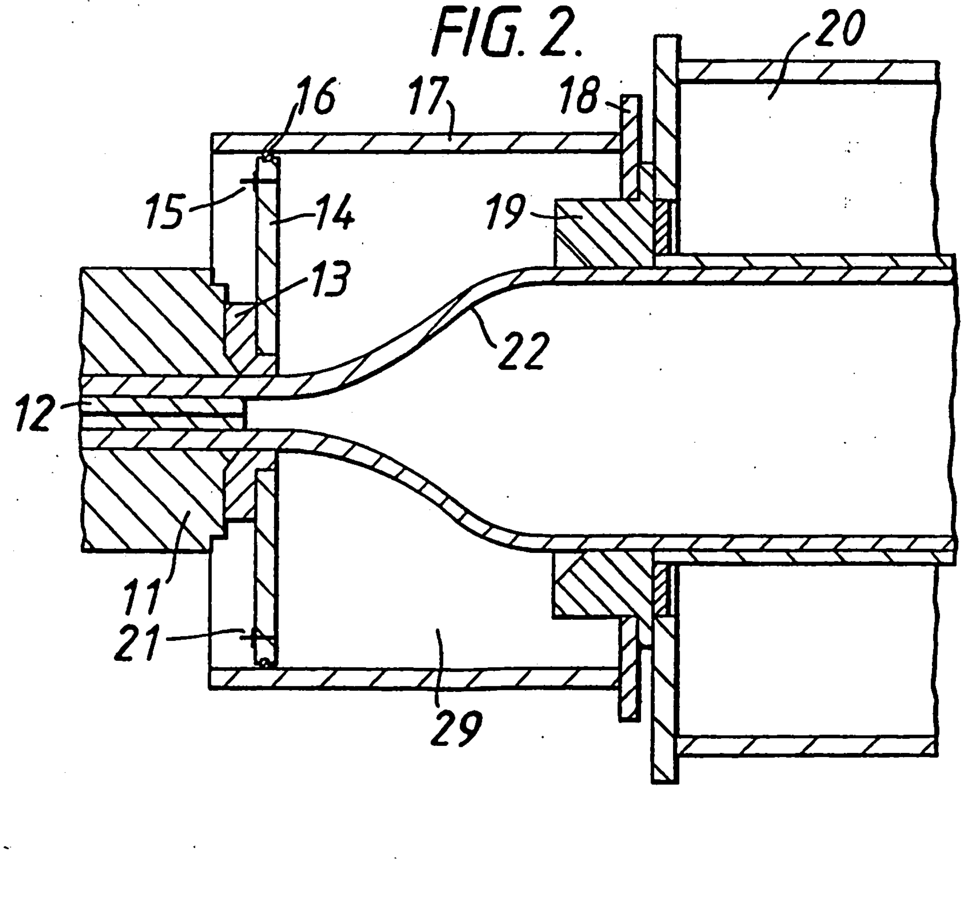


FIG.2.



SPECIFICATION

Improvements in r relating to the extrusion of products

This invention relates to the extrusion of products. More particularly, the invention relates to the extrusion of products in a hollow form, which may be retained as such as pipes or tubes or may be slit longitudinally to form channels or strip shaped products. Such products may be formed of thermoplastics materials or rubber, including synthetic rubber, wherein the material from which the product to be extruded is melted or plasticated in a screw mixing cylinder or ram pressure cylinder and forced through an annular die of the required sectional configuration of the hollow form of the product. The basically crude shape so extruded must be calibrated and cooled to give a formed extrudate of the required dimensions.

Commonly, with pipes and tubes for example, this has hitherto been done by means of either pressure calibration or vacuum calibration. Typically, with pressure calibration the pipe, after extrusion from the mandrel, is immediately passed through a cooling forming box through which cold water circulates. Calibration and heat transfer are aided by the application of an internal pressure within the pipe which, in practice, is maintained by sealing the advancing pipe end or by use of a sliding internal bung within the advancing pipe connected to the mandrel by a cable. Similarly, typical vacuum calibration is by passing the pipe direct from the forming mandrel into a perforated sizing sleeve or set of sizing rings or plates around which a vacuum is applied. The bore of the pipe remains open to atmospheric pressure thus providing, across the pipe wall, a pressure difference during cooling.

It has been proposed to reinforce and strengthen such extruded products by means of reinforcing fibres, of glass for example, mixed with the product material.

In products produced by such extrusion method the fibre reinforcement will, due to the polymer flow path in the die lying along the length of the pipe, have a high proportion of fibres aligned along the length of pipe or hose. In a pipeline, for example, under pressure from within, or being subjected to high soil loading characteristics or factors from without, the high stresses developed in the pipe will most significantly be in the circumferential or hooped direction. Fibres aligned parallel to this direction i.e. down the length of the pipe or hose contribute nothing to the circumferential strength of pipe or hose and all the hoop stresses are carried by the plastics or rubber matrix.

It is an object of the present invention to overcome, or at least substantially reduce, the above mentioned difficulty.

In accordance with one aspect of the present invention there is provided a method of producing an extruded product comprising the steps of melting or plasticating the material of the product and forcing it through an annular die to form an elongate hollow product, wherein the hollow product, after passing through the die, is subjected to a pressure difference across its side walls whilst soft and thereby expanding the hollow product transverse to the axis of extrusion and calibrating and cooling the product in its expanded configuration.

The expanded product may be calibrated and cooled by means of a vacuum sizing sleeve for vacuum calibration or by a former box for pressure calibration.

In accordance with another aspect of the present invention there is provided apparatus for producing an extruded product comprising means for melting or plasticating the material of the product; an annular die through which the material is forced, to form an elongate hollow product; means for applying a pressure difference across the side walls of the product after the forming die to expand the product transverse to the axis of extrusion; and means for calibrating and cooling the product in its expanded configuration.

The material of the product itself may, for example, be thermoplastics material or natural or synthetic rubber. The material from which the product is formed may be reinforced with fibrous material, such as glass fibre, or be a self-reinforcing polymer such as a liquid crystal polymer.

It has been found that the lateral expansion of the hollow product as it emerges from the mandrel and die provides, in practice, a considerable fibre reinforcement orientation in the hoop direction of the product thereby increasing the hoop or lateral strength of the product.

In order that the invention may be more readily understood, one embodiment thereof will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a diagrammatic sectional elevation of apparatus for forming a tube or pipe according to the invention;

Figure 2 is a variation on the apparatus on Figure 1;

Figure 3 is a further variation on the apparatus of Figure 1.

Figure 4 is an alternative arrangement of part of the apparatus of Figure 2; and

Figure 5 shows a vacuum control for use with the apparatus of Figures 2 or 4.

Referring now to Figure 1, it will be seen that a soft tube of plastics material 1 (e.g. medium density polyethylene) is extruded from a die body 2 about an internal mandrel 3. Air is passed through a passage 4 in the mandrel so as to provide within the tube after extrusion an internal air pressure P. To maintain the air pressure, the tube end may, in a manner not shown, be crimped over, or an internal plug may be provided within the tube connected to the mandrel in the previously mentioned manner. After leaving the mandrel and die the still soft pipe expands in a "bubble" 7 due to the pressure difference across its side wall, passes through a sizing sleeve 5 and then enters a perforated sleeve 6 in a vacuum spray tank 8 where the expanded dimensions of the pipe are retained whilst it is co led. It is to be noted that the external diameter of the tube increases from D1 to D2 whilst the wall thickness may change from W1 to W2 in the formed pipe. It has been found that th shape of the melt "bubble" 7 for expanded portion of soft tube

can be controlled by varying the distance between the die 3 and the vacuum spray tank 8.

As previously stated, it has been found that this technique increases the orientation of fibre within the plastics in a hoop direction. There are, of course, a number of factors influencing the degree of fibre orientation in the hoop direction, these including the ratio of D1 to D2 and the ratio of W1 to W2 as well as the ratio of the melt velocity in the die and the formed pipe velocity as it is withdrawn, the shape of the expansion "bubble" of the still soft pipe, and the die swell of the polymer melt.

Whilst the invention described in relation to Figure 1 has proved successful, in some circumstances the use of an above atmospheric pressure within the pipe might possibly cause difficulties in association with a vacuum calibration technique, such as poor stability of the melt "bubble".

This potential slight problem is overcome with the embodiment of Figure 2.

With regard to Figure 2, it is to be seen that, in addition to the apparatus illustrated in Figure 1, an additional vacuum chamber 29 is fitted around the space between the die 11 and mandrel 12, and the end of the vacuum spray tank 20. In this instance, the bore of the formed pipe is left open to the atmosphere and the additional vacuum applied to the still soft pipe as it emerges from the mandrel acts in place of the air pressure within the pipe to create the expansion "bubble" 22.

The plate 14, separated from the die 11 and the mandrel 12 by a p.t.f.e. ring 13, is fitted with a rubber seal 16, allowing movement between the end plate and sizing sleeve 19. In this way the vacuum tank 20 may be withdrawn allowing access to the die outlet to facilitate ease of starting extrusion, or it may be moved during running to allow adjustment of the bubble size in addition to varying the vacuum level. The additional vacuum chamber is completed by perspex tube 17. Vacuum and manometer inlets 15 and 21 are provided.

Figure 4 shows an alternative embodiment of rubber seal 30 attached to the end plate 14. This arrangement allows greater capability of sealing under slight misalignment of the extrusion die 11, end plate and the additional vacuum chamber. In each case, the rubber seal enables an effective vacuum to be maintained within the additional vacuum chamber, whilst enabling adjustment in its effective overall internal length.

In Figure 3, the additional vacuum chamber disposed between the die body and the vacuum spray tank is replaced by a forming block 10 manufactured from an appropriate material such as perforated polytetrachlorethylene or ceramic material. As can be seen, the forming block has an internal configuration 11 corresponding to the desired outside configuration of the expansion "bubble" 7 of the pipe on leaving the mandrel. The forming block may be drilled from solid material or constructed from a porous material so that, in either event, a vacuum can be applied to the outside periphery thereof so as to apply to the still warm, just formed pipe, an appropriate vacuum to draw it against the internal shaped surface 11 of the block 10. With such an arrangement the internal profile of the block can be so shaped as to give optimum orientation of the fibre reinforcement in the plastics material of the pipe for both longitudinal and hoop strength.

It is to be noted that in this embodiment also the bore of the pipe is open to atmospheric pressure, although, alternatively, it can be closed and under positive pressure.

Figure 5 shows a simple vacuum control circuit which may be used in combination with the additional vacuum chamber to give fine adjustment of the bubble size. It comprises a vacuum pump 31 connected via line 32 (having a bleed valve 33) to additional vacuum chamber 29. A manometer 34 is also connected, via an isolation valve 35, to chamber 29.

The process of controlling fibre orientation hereinabove described in relation to pipe and tube may be applied to other profiles that are not of circular cross section as in pipes and hoses. Thus, oval or rectangular sections can be similarly treated. Again, the possibility of producing open sections with controlled fibre orientation by slitting and opening profiles can be provided. By way of example semi-circular and U channels, or even flat sheet, can be produced.

It is to be noted that standard extrusion dies can be utilised. The method is applicable to a wide range of pipe extrusion materials.

CLAIMS

1. Apparatus for producing an extruded product comprising means for melting or plasticating the material of the product; an annular die through which the material is forced, to form an elongate hollow product; means for applying a pressure difference across the side walls of the product after the forming die to expand the product transverse to the axis of extrusion; and means for calibrating and cooling the product in its expanded configuration.

2. Apparatus as claimed in claim 1 wherein the means for applying a pressure difference across the side walls of the product includes means for increasing the pressure within the product after it leaves the die.

3. Apparatus as claimed in claim 1 or 2 wherein the means for applying a pressure difference across the side walls of the product includes a vacuum chamber through which the product is arranged to pass after it leaves the die.

4. Apparatus as claimed in claim 3 wherein an additional vacuum chamber is provided surrounding the product exit from the die.

5. A method of producing an extruded product comprising the steps of melting or plasticating the material of the product and forcing it through an annular die to form an elongate hollow product, wherein the hollow product, after passing through the die, is subjected to a pressure difference across its side walls whilst soft and thereby expanding the hollow product transverse to the axis of extrusion and calibrating and cooling the product in its expanded configuration.

6. A method as claimed in claim 5 including increasing the pr ssure within the product to xpand it.

7. A method as claimed in claims 5 or 6 including applying a vacuum around the product to expand it.

8. A method as claimed in claim 7 including applying a vacuum around the product as it leaves the die to expand it.

9. A method as claimed in any one of claims 5 to 8 wherein the expanded product is calibrated and cooled by means of a vacuum sizing sleeve or by means of a pressure former box.

10. A method as claimed in any one of claims 5 to 9 wherein the product is a thermoplastics material or natural or synthetic rubber reinforced with fibrous material.

11. A method as claimed in any one of claims 5 to 9 wherein the product is a self-reinforcing polymer.

12. Apparatus for producing an extruded product substantially as shown and as hereinbefore described with reference to the accompanying drawings.

13. A method of producing an extruded product substantially as hereinbefore described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by
Croydon Printing Company (UK) Ltd, 3/87, D8991685.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

2/3

FIG. 3.

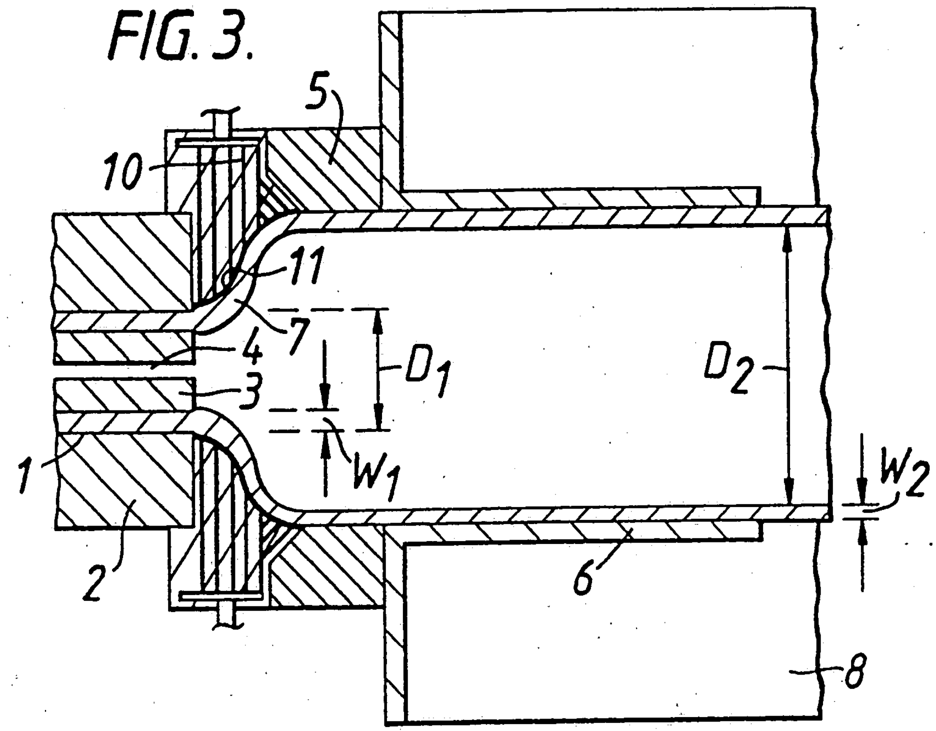


FIG. 4.

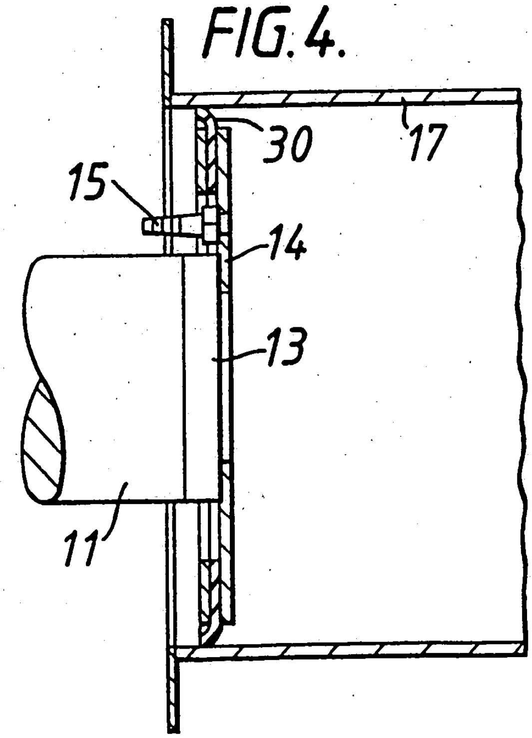


FIG. 5.